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FOREST SERVICE

APPALACHIAN FOREST EXPERIMENT STATION

Asheville, N. C.

SEVENTEENTH ANNUAL REPORT AND PROGRAM

1937

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APPALACHIAN FOREST EXPERIMENT STATION

Two important developments in 1937 have increased the responsibilities of forest research in the Southern Appalachian Region. The most significant of these was the voluntary adoption of cutting regulations by the pulp and paper industry in the South. For the first time a major wood-using industry has made an attempt to impose upon itself regulations that seek to assure a permanent supply of raw materials. While these regulations may be considered as only partly meeting requirements, it is accepted that the application of even the simpler techniques of forest management will greatly increase the volume of growing stock and hence the productive capacity of genenerally understocked forest lands. Much additional research is needed before comprehensive recommendations covering the great variety of forest stands can be made.

The other major trend has been toward the recognition of values to be derived from planned land use. Public conviction that much of the area in the region can better be used for purposes other than agriculture has been stimulated by recent legislation and by activities of conservation agencies. As a result, specific land zoning measures can be expected to follow the present more or less academic consideration given to land planning. It seems that public acquisition of much submarginal land, and thus a greatly expanded forestry program, is inevitable. More important, however, is the need for balancing agriculture and forestry on a large number of the several hundred thousand farms in the region. Much of the Station's research program in the future will be directed toward the solution of farm forestry problems.

Accomplishments

The rehabilitation of mixed hardwood stands continues to be a major problem in the mountain region. Crop tree cleanings, which show considerable promise of being an effective method for improving the large area of young growth which has arisen as a result of past logging, have been widely used since the inception of the C.C.C. However, due to the differing reactions of species to different treatments, specific standards for crop tree treatment can not be made without detailed investigations such as were begun by the Station several years ago.

Remeasurement of crop trees which have had only one year to grow since treatment show some interesting trends. The first year's reaction of sugar maples in the Monongahela National Forest experiments suggests that only dominant and codominant trees should be chosen for crop trees in young stands. Although no difference in the breast-high diameter growth between the four treatments used has yet appeared, the treated trees as a whole grew two and two-thirds times as much as trees not treated. Trees which were dominant before treatment averaged 0.32 inches D.B.H. growth during the first season following treatment; while average growth for codominants was 70 percent; for intermediates, 42 percent; and for overtopped trees, only 25 percent of this amount. Sweep in the stems, or bending, was found to have increased in 20 percent of the lightly treated trees, in 24 percent of those heavily treated, and in 7 percent of the checks. However, only 3 percent of the dominant trees showed an increase in sweep, while 15 percent of the codominant, 23 percent of the intermediate, and 27 percent of the overtopped trees showed such increases. This increase in sweep may be due to the removal of mechanical support which resulted from the cleaning, or to the weight of snow, or both. Snowfall during the winter following treatment, however, was only about 50 percent of the average annual fall for the three previous years. With a normal season these percentages would doubtless have been greater. New sprouts appeared on 47 percent of the treated crop trees and on 28 percent of the checks. Only 21 percent of the crop trees which were dominant and 29 percent of those which were codominant before cleaning showed new sprouts, but such sprouts appeared on 42 percent of the trees in other crown classes.

White oak crop trees on the Jefferson National Forest treated at the same time and in the same way as the sugar maples showed no increased diameter growth and produced very few water sprouts during the first growing season following treatment. Delayed response to treatment was also discovered in a study of white pine liberation where for two years after treatment the released pine understory showed no greater growth than the controls. By the fifth year, however, the difference was highly significant, treated trees showing an average height increase of 10.2 feet during the five years, as compared to 7.6 feet for untreated controls.

Cleaning studies were expanded during the past year to include yellow poplar. The four standard types of treatment were applied to crop trees of this species on the Jefferson National Forest.

During the past summer a market for oak pulpwood developed in western North Carolina. Should this market expand, the opportunities for profitable improvement cuttings would be considerably enhanced. Study on a timber sale of oak pulpwood plus such saw logs as could be harvested, was made on the Bent Creek Experimental Forest. The cutting, covering 40 one-acre plots distributed over a stand of mixed oak, was primarily for the purpose of removing defective, poorly formed, and overmature trees. Mensurational phases of the work have been completed and include (a) a study of the factors affecting the solid cubic contents of stacked wood and determination of stacked cord-cubic foot converting factors and (b) construction of volume tables giving the cubic foot and stacked cord contents in the tops of oaks of different sizes. It is usually assumed that the solid cubic contents of stacked wood increases with increases in size of sticks in the pile. However, the opposite relationship was found in oak pulpwood split largely from cull pieces and limbs because increases in solid volume were associated with increases in the number of sticks per cord. Solid cubic volume was also found to increase as the proportion of round sticks in the pile increased.

Efforts to develop, through tree classification, standard criteria upon which hardwood timber marking could be based continued during the year. The first exploratory work which appeared nearly complete a year ago resulted in a chart from which the current annual increment could be estimated with reasonable accuracy by means of external tree characteristics. However, field tests showed the need for certain improvements which are now being made.

Since a knowledge of the results of past cuttings should be of service in the further development of silvicultural practice, the Station is conducting an analysis of the conditions that have followed cutting, using about 400 field tallies made on cut-over areas in the mountain region, mostly on the national forests. The purpose of the study is, first, to describe and classify the various conditions of residual stand and reproduction set up as the result of different kinds of cutting in different forest types; and second, to determine significant tendencies in the relations of the old and young stands as to composition, density, and quality. Preliminary analysis of 60 combinations of the cut-over area field data showed numerous correlations between different classes of reproduction that were significant or highly significant. Among tentative results are the following:

(a) The proportion of desirable species averages conspicuously less in dense than in sparse reproduction. In cuttings less than 10 years old, desirable species form 60 and 23 percent where the reproduction is 300 and 2000 per acre, respectively; the corresponding percentages in older cuttings are 83 and 26.

(b) The average proportion of free to total reproduction is about the same (about 55 percent), regardless of age of cutting, where the total reproduction is only 300 per acre; but as the density of the reproduction increases to 2000 per acre, the proportion of free reproduction decreases to 40 percent for the younger and 20 percent for the older cuttings.

(c) For residual stands containing 100 trees per acre the number of free reproduction per acre tends to be about the same (about 420), regardless of the age of cutting; for stands containing 300 residual trees, the free reproduction per acre 12-19 years since cutting (200) is only a little more than half the number on areas cut over less than 10 years.

(d) The proportion of seedlings (including seedling sprouts) to the total reproduction decreases with increase in density of reproduction in both recent and old cuttings. The proportion is greater in the older cuttings.

(e) The proportion of free seedlings of desirable species to the total free reproduction decreases with the density of the latter, very markedly in cuttings less than 10 years old, very slightly in older cuttings.

(f) In the 4"-10" d.b.h. class, the older cuttings show a tendency toward increase in number of "good" trees with density ranging from less than 10 percent where the total residual stand contains 100 trees per acre to over 50 percent where it contains 250 or more.

These tentative results point generally to the greater need of cleanings in dense than in sparse reproduction in order to increase the proportion of (a) free reproduction, (b) desirable species, and (c) seedlings. The decrease in the proportion of free reproduction with time since logging emphasizes the need for early selective cleanings, as does also the greater proportion of "good" 4"-10" d.b.h. trees in the denser stands on old cut-over areas.

Plans for 1938

Work on tree classification will be continued and the improved method submitted to cooperating agencies for trial.

Two new studies proposed for the coming year are (1) establishment of thinning and stand improvement tests in second-growth hardwoods of the 20-40 year age classes, and (2) a study of the factors affecting the development of water sprouts on yellow poplar and white oak in stands where partial cutting has been practised. The first of these projects has a two-fold objective. The one of major importance is to develop thinning methods which will increase or at least prolong early rapid volume increment per acre on residual stands and at the same time maintain clear stem length on chosen crop trees. The second objective is to determine the actual volume of usable minor products produced by the various methods and the man hour costs per volume unit required by each of the several methods.

The investigation of the factors affecting the development of water sprouts is a short-time study and will be conducted on areas in West Virginia, Virginia, and North Carolina where the Station has established partial cutting plots in past years.

In the cut-over area study, the tentative conclusions derived from grouped tallies are to be verified by using the large number of individual

tallies. The analysis will also be extended to other variables. The effect of crown expansion of residual trees upon the proportion of free reproduction will be indicated by analysis of successive crown maps and successive tallies of permanent sample plots. The project includes a study of the change in composition which has taken place as the result of the death of chestnut.

Accomplishments

In the Piedmont region major adjustments in land use are inevitable because of the economically intolerable type of agriculture being practised on a vast acreage of impoverished and eroding soil. Enlightened public support of Federal legislation enacted or pending points to the early withdrawal of much land from agricultural use. Afforestation appears to be the principal solution in the rehabilitation of such lands because of the dual benefits of soil betterment and monetary return. Fortunately, many of the soils now producing low agricultural yields are capable of supporting timber crops excellent as to both rate of growth and quality of product. The major forest research objectives in the Piedmont, therefore, are the determination of the most effective and economical methods of afforesting former agricultural lands, and a study of farm wood-lot management that will return the greatest income to the farmer. Accomplishment of these objectives, together with the promotion of better soil-conserving practices by other agencies, will go far in raising the economic level in the region.

During the past year two major studies were conducted in the Piedmont. The purpose of the first was to obtain data on the growth, yield, silvical and botanical characteristics, and management of Virginia pine. The second study was designed to determine, from extensive surveys, the factors affecting the natural reforestation of abandoned farm lands.

Analysis of the Virginia pine data has permitted the construction of volume tables and yield and growth tables for non-normal stands. The latter tables are based upon 165 temporary plots well distributed over the territory. During the preparation of the non-normal yield tables, a much-simplified form of yield equation was developed, which additional work showed to be equally applicable to loblolly pine. Although this development is primarily research in pure mensuration, it is a distinct contribution to the technique of estimating yield on non-mormal stands of species which tend to grow in even-aged groups. Considerable information on the silvical and botanical characteristics of Virginia pine has also been compiled for the proposed bulletin manuscript.

During the course of the second study, Piedmont sections of South Carolina, North Carolina, and part of Virginia were covered by reconnaissance and case studies of selected fields. It was found that the most important single factor affecting the regeneration of old fields was the condition and extent of the adjacent seed source. Thin, spotty, uneven-aged reproduction so common to the formerly cultivated lands of the Piedmont is primarily a result of inadequate seed supply, and is only secondarily influenced by such factors as soil type, severity of erosion, density and type of ground cover, topographic position and variation in weather conditions from year to year. An adequate seed source is defined as a 50 percent to fully-stocked stand, or at least the essential equivalent of a closed row of thrifty, vigorously-growing trees with well-developed crowns, 40 years or more of age and extending along one entire

side of the field. It was the general observation that unless a seed source of this type were available adequate reproduction of adjoining open areas would be relatively slow and incomplete. Where such a seed source exists, and if 1,000 seedlings per acre is taken as a standard of satisfactory restocking, the effective seeding range of the source was found to be approximately five chains. If, however, 500 trees per acre is accepted as satisfactory stocking, a good seed source can produce this density of seedlings for a distance of approximately seven chains. If the timber producing capacity of the land is to be utilized fully, artificial reforestation is indicated wherever the seed source fails materially to meet the previously-mentioned specifications. Even where a good seed source is available, planting also is indicated in field where a large proportion of the area is outside the five- to seven-chain distance.

Data from experiments on effects of different methods and conditions of stratification on the germination of loblolly pine seed amplify the previously established basic principles of the limits within which the different factors are effective. The information acquired will enable nurserymen to stratify their seeds with much greater certainty of obtaining the desired improvement in germination.

The most important conclusions are:

1. The stratification medium must be thoroughly moist.

2. The water content of the medium can vary within wide limits (25 to 100 percent of capacity) without apparent change in the efficacy of the treatment.

3. Sand and peat are equally effective as stratification media.

4. Temperatures throughout the period of treatment should be near or slightly above 32° F., and should not exceed 40°.

5. Higher temperatures (approximating 50° F.) accelerate the changes induced in the seeds by the stratification treatment, but result in losses of vitality if continued for three months or more. Such temperatures should be employed only when the time available before the seeds are to be sown is less than two months.

6. Stratification at 32° - 40° F. for three months reduced the time required for the completion of germination to slightly more than one-half of that required by dry controls. This treatment is recommended.

Work on a tree classification for second-growth loblolly pine was begun during the year. It was found that a reasonably accurate estimate of current volume growth can be made for individual trees by means of their breast-high diameter, age, and crown factor, the figure obtained by adding crown width in feet to crown length in feet. As with the hardwood tree classification carried on under the mountain hardwoods project, certain improvements will be necessary before the classification can be considered applicable. The technique for making these improvements is

now being tested for white oak under the mountain hardwoods project and will be applied to the loblolly data when its success with the other species has been established.

Bark thickness data for loblolly pine trees were analyzed to find the (1) relation of bark thickness and d.i.b. at top of first log to d.b.h. o.b., (2) variation of bark thickness within trees, and (3) factors affecting bark thickness at b.h. Tentative conclusions indicate that:

1. Diameter o.b. is the most significant factor affecting bark thickness at any point on tree. Bark thickness decreases with decreases in diameter.

2. Position on tree influences bark thickness. For equal diameters, bark thickness decreases with increasing height above ground of point at which measured.

3. Stand origin affects bark thickness. Trees of forest origin have thicker bark than those of old field origin.

4. Form class (ratio d.i.b. top of first log to d.b.h. o.b.) is influenced to the greatest extent by total height of tree and very little by d.b.h. Form class increases with height of tree.

Plans for 1938

Completion of the Virginia pine study will take high priority in the work program for the coming year. Much computation work and the preparation of the manuscript must be finished. It is proposed to publish the results of this study as a Department bulletin.

An analysis of the forest problems in the Piedmont is also of great importance. Necessary data have been collected and partially compiled, and practically no more field work is contemplated. Two problems, studies of the means by which abandoned agricultural land can be reforested and methods of cutting second-growth pine for pulpwood, are so obvious that no regional analysis of forest conditions is necessary. New work on phases of both of these studies will be started during the coming field season.

In connection with the first of these problems an extensive test of seed spotting methods will be made in both the northern and southern Piedmont, using loblolly, shortleaf, and possibly Virginia pine. Correlated with the seed spot experiments will be a study of the factors affecting survival of seedlings during the first growing season. This will require periodic records of maximum and minimum surface soil temperatures, and the determination of soil moisture for each of the seed spot treatments under test. The results should show the conditions responsible for success or failure in the establishment of pine reproduction.

Pulpwood cutting experiments in second-growth pine will be confined largely to areas within the loblolly range and will be designed to test not only the pulpwood yield obtained from various cutting methods, but also the growth of residual stands left after thinning, and the success obtained in establishing reproduction under different methods of seed tree cutting.

MANAGEMENT - COASTAL PLAIN

Accomplishments

With the tremendous expansion of wood-using industries in the Coastal Plain region of the Station's territory, the need is apparent for basic information from which sound cutting practices can be derived. Whether some form of selective cutting or some modification of clear cutting will result in the greatest long-time economic benefits in harvesting pine timber, is still controversial. The forestry profession has been called on by the pulpwood industry for technical advice in matters bearing upon the industry's efforts to regulate its own cutting practices. Although public foresters have rendered such assistance, they recognize the weaknesses of the basic information upon which the recommendations rest.

The problem of how pine can be maintained after cutting in stands where an understory of weed species exists, is widespread in the Coastal Plain region. Methods of cutting by which pine may be reintroduced into the dryer site hardwood stands is another problem of some importance. The pine component of these mixed stands is being continually culled out with very little opportunity of replacement under present practice.

Coastal Plain field work during the past year has been confined to reexaminations of the plantation established in connection with the loblolly pine one-parent heredity study. Two growing seasons have elapsed since this plantation was established, but it is not proposed to attempt an anlysis of the records until the results from at least two more examinations are available.

Cost production data obtained in 1931 from a sawmill located in the South Carolina Coastal Plain were analyzed to determine the relation between tree age and lumber value of loblolly pines. The stand from which the trees were obtained had received a partial cutting 40 years prior to the time of the study, and three rather distinct age classes were present. The following tabulation summarizes the results of the analysis:

Values per M board feet of lumber tally.
Percent uppers (B&B, No. 1 and C) of total volume.

Age class	Value per M	Percent uppers
40 years and less	$ 21.26	13.0
41 - 80 years	24.09	33.6
More than 80 years	26.68	50.4

The increase of both value per M board feet and percent uppers with age in partially cut stands is of importance in stumpage appraisals, computation of diameter cutting limits, and rotation age.

Plans for 1938

Because funds for work in the Coastal Plains are lacking, continuation of the few existing minor projects only is proposed.

PLANTING

Accomplishments

The two outstanding general planting problems in the mountain region served by the Station are the abandoned agricultural lands located primarily in the Cumberland foothills of Kentucky and Tennessee, and the cut-over spruce lands of the high mountain country. Social and economic conditions in the first of these areas are similar to those in the Piedmont. Rehabilitation of submarginal land, in part through reforestation, is already under way by several public agencies. Thus far, planting has been confined primarily to one or two species with which success is fairly sure. There is some evidence that the more valuable species, particularly hardwoods, may be successfully established on certain soil types, but proof of the adaptability of various species to specific soils is necessary before such species can be safely included in large scale planting projects.

In the cut-over spruce type, areas that were formerly occupied by forests of high value now support new growth of little value because of the type of cutting practiced followed by fire. Here need to be determined site conditions that will allow the successful reforestation of red spruce and the adaptability of other species, primarily certain northern hardwoods.

Field preparations for a series of large-scale planting tests in the Cumberland foothills have been under way since early summer. The areas are located on lands of the Tennessee Valley Authority which has provided excellent cooperation in both the planning and execution of the work. Experiments have been designed to determine:

(a) The influence of soil type and aspect upon the survival and later growth of 9 hardwoods and 2 coniferous species.
(b) The influence of a black locust mixture upon the survival and growth of 3 hardwood and 1 coniferous species.
(c) The comparative success of 10 different mixtures of 6 hardwood and 3 coniferous species and their relation to soil type and aspect.
(d) Which, if any, of 8 hardwood and 2 coniferous species can be successfully established under the sassafras stands that occupy many abandoned fields.
(e) The effect of various methods of treating the sassafras overstory upon the survival and growth of 2 hardwood and 1 coniferous species.
(f) Which of 5 hardwood and 2 coniferous species can be successfully established as an interplanting of understocked shortleaf pine stands.

Planting of approximately 1/2 of the experimental plots will be completed this coming April, the remaining half will be finished during the next planting season.

Procedures for making survival counts in forest plantations, based upon a system of random sampling have been the subject of investigation during the past year. The objectives of the work are to determine the error of estimate of survival in various plantations and to compare the results and costs of the random sampling method with procedures now in common use.

In cooperation with local forest officers experiments were established last spring in two plantations on the Uharie Unit of the Sumter National Forest and reexamined after the first growing season. Plans for two similar experiments were also made last spring by representatives of R-7, the Monongahela National Forest and the Experiment Station.

Plans for 1938

The remainder of the spring season will be required to complete the current planting scheduled for the experiments under way in cooperation with the T.V.A. First season survival counts and analysis of the results will be made later in the year.

The two experiments established on the Monongahela as part of the test of procedures for making survival counts are scheduled for reexamination this spring. After this reexamination has been completed, the Uharie and Monongahela data will be analyzed and a report of the current results prepared.

A new project for the coming year will be an analysis of the planting problems in the cut-over spruce lands of the high mountain country. This study will attempt to classify the soil and vegetative types and to outline the specific conditions that planting experiments should sample. The project is basic to the intelligent planning of planting experiments which will be started upon completion of the problem analysis.

No research in planting is contemplated for the Piedmont. Proposed investigations on other artificial means of reforestation are discussed under the section, Management.

Accomplishments

In the past few years there has been a definite trend away from rule-of-thumb fire prevention and control in the East. It has become evident that carefully developed technics must replace many rule-of-thumb practices before financially-sound prevention and control can be achieved.

The Appalachian Forest Experiment Station has contributed to the evolution of scientific and economical fire control by shaping its fire investigative program to give emphasis to the development of basic fire planning methods. In the past year, especially, the work has been aimed at solving specific administrative fire control problems.

The rates of spread and resistances to control offered by fires burning in different kinds and volumes of fuel are fundamental considerations in fire planning work. Fuel type is of primary importance in determining the most advantageous location of lookouts, roads, trails, communication facilities, and manpower. The rates of spread and resistances to control of fire, in short, determine the speed and strength of attack necessary to attain satisfactory control objectives.

One recent contribution of the Station was the preliminary identification of rates of spread and resistance to control associated with fires burning in 15 fuel types common to eastern forests. These data were obtained from 1,568 fire reports, analyzed in cooperation with Region 7. This preliminary study showed that the rates of spread and resistances to control of the 15 fuel types possibly may be grouped into four classes. Investigation of the fastest spreading 25 percent of the fires in the major types revealed that the average spread is about two and one-half times greater than the average for fires burning in the most extreme rate of spread fuels in Region 1. Resistance to control, however, is about equal to the average for other regions.

A method for planning a detection system based upon occurrence, fuel type, normal visibility, and potential damage was described in "Planning a Lookout System," a mimeographed Station publication. This summarizes all of the methods of lookout-point value compilation developed and tested during the past three years. The planning method is based on the principle that each lookout is part of a coordinated system, in which the location of one detection station affects the correct location of others. The selection of the points that make up a detection network depends on the relative occurrence of fire, fuel types, and values associated with the areas that are visible under normal atmospheric conditions from each potential lookout station.

Determination of the current visibility distances of small smoke columns is necessary for the most efficient operation of a fire control organization. When the atmosphere is clear, a few lookouts can discover

fires within a satisfactory time, but when the air is hazy a greater number is required. When the latter atmospheric conditions prevail, good fire control practice demands either added detection or greater speed and strength of attack. Measurements of visibility distance are therefore helpful in determining the changes that should be made in an organization from day to day. Records of normal visibility distance are also required for detection planning.

While an instrument for measuring visibility distance in mountainous country has been in use for some time, until recently no device was available for the large areas of flat or rolling Piedmont and Coastal Plain. The Plains haze meter, a photometer for estimating safe visibility distance of smoke in flat or gently rolling country, has been developed and checked in the field. The instrument measures haze by comparing the brightness of some selected target with the brightness of the horizon in the same direction. From haze meter readings visibilities are obtained in mile units rather than in terms of haze brightness or air clearness. This new type instrument should be a material aid to fire control in the extensive forested plains.

A major accomplishment during the past year has been the development of the Appalachian fire danger meter in cooperation with Regions 7 and 8. This device integrates the principal temporary or fluctuating danger variables and expresses the resultant on a numerical scale of 1 (no danger) to 5 (extreme danger). The factors integrated by the meter are: (1) fuel dryness as indicated by amount of rain, time elapsed since rain, and relative humidity; (2) wind velocity; and (3) season of the year. Additional allowances are made for poor visibility conditions but only when they coincide with high fire danger. The types of organization that are usually required for each class of fire danger are defined in general terms on the meter. During the past season the meter was checked at 55 stations on eight forests in the southern Appalachians.

The accuracy of the danger meter as well as the preliminary figures on rate of spread and resistance to control associated with fuel types are being checked currently by observations on going fires. The Station has trained a total of 125 C.C.C. fire observers at ten schools on six forests in Regions 7 and 8. These men accompany suppression crews and record data on rate of spread, fuel type, and weather.

The fire danger meter not only provides current ratings that can be used as dispatcher guides, but it permits exact comparisons of the severity of seasons or years on ranger districts, forests, or in entire regions. Severity ratings are essential before valid statements of the efficiency of fire prevention and control organizations can be made. Knowledge of normal danger, measured and rated numerically, is necessary if fire control expenditures are properly balanced among several protection units.

Because of the rapidity with which conditions may change in the light-weight fuel types common in the region, a forecast of fire danger is desirable. Predictions of dangerous conditions enable a ranger to

plan and execute changes in his organization prior to their arrival and make possible the most efficient and judicious handling of funds. The Station has developed a preliminary meter that rates tomorrow's danger as well as today's. The ultimate success of such a device, of course, depends largely on the accuracy with which weather can be predicted. Adequate personnel and facilities for expanding the fire-weather network, handled by the Weather Bureau, are essential if this scheme is to succeed.

A search for a practical field method of fuel moisture content determination, including checks of many methods used elsewhere, has resulted in the adaptation of the Region 1 wood stick method of moisture determination to Appalachian conditions. It has been found that flat basswood slats respond to atmospheric changes in much the same way that surface hardwood leaves react. Periodic weighings of standardized wood sticks, exposed under natural conditions, thus provide indices of actual fuel moistures. Eventually, fire danger stations will be equipped to measure fuel moisture and the danger meter will be simplified by the use of this variable.

In the field, determination of the moisture content of wood sticks will be simplified by our recent development of a moisture content scales. In use, a set of wood sticks is hung on the balance and a direct reading of average moisture is obtained. A sliding adjustment on the balance arm of the scale adapts it to sticks of different oven-dry weights. This is an advantage over similar devices used in other sections of the country.

Several other fire behavior and fire control studies have been completed in the past year. Identification of the probability of occurrence, rate of spread, resistance to control, and cost associated with each of the five fire danger classes was determined from analysis of 460 Pisgah Forest fire reports. The findings from this study should help dispatchers recognize the differences to expect on easy, average, and bad fire days. For example, the chances that a fire will occur on a class 5 day are about 29 times greater than on a class 1 day. Average rate of spread in chains of perimeter per hour on a class 1 day equals 1.3 compared to 16.2 on a day of extreme danger.

Various fire investigators have fostered the idea that leaf-breaking tests might be used as a general field index of litter moisture content. Results of more than 500 tests on post, scarlet, and southern red oak leaves, however, indicate that variation among leaves of a given species precludes the possibility of this method being used for moisture content determination.

The Station, cooperating with the Forest Products Laboratory in comparing the effectiveness of various chemical solutions to that of water as fire extinguishers, assisted in making tests on more than 200 experimental fires in the hardwood leaf litter fuel type on the Bent Creek Experimental Forest during the past fall. Additional tests during the spring fire season are planned.

With the more or less recent emphasis being given to fire prevention and control planning, it should be kept in mind that expenditures can best be justified on the basis of the total damage that fires cause. Damage to forest vegetation and site is therefore one important consideration in the determination of fire control objectives. Such data are of value to those who must show the need for funds to protect tangible values before allotments will be made. A knowledge of effects of fire is also essential before damage appraisals can be made.

During the past year the Station cooperated with Forest Pathology in making a study of the cull in white oak following fire so that a method of predicting cull for damage appraisal could be determined. The data were analyzed to show the relation of cull to wound width, age of wound, and diameter of tree at time of wounding. Annual examination of tree mortality on permanent sample plots was made.

Plans for 1938

A final analysis of haze meter and weather records, gathered over a three-year period, will be made to establish the relation between visibility distance and (a) hour of day, (b) season, (c) geographical region, and (d) weather. It is hoped that a method for predicting visibility can be developed from this analysis. Two new visibility studies are planned to determine the importance of visibility distance as a fire danger variable. The first of these deals with the relative visibility of smokes within the visual range; the second, with the volume of smoke produced by a fire as related to fuel moisture, fuel type, and rate of spread.

The check of rate of spread and resistance to control classifications of fuel type will be continued by C.C.C. fire observers. The Station will analyze these data currently.

It is planned to continue testing the fire danger meter, work toward standardization and simplification of measurement, and supervise establishment of additional danger stations. The new meter that forecasts danger will be checked in the field.

A fire danger meter applicable to the Piedmont and Coastal Plain forests of North Carolina and South Carolina will be developed and tested.

The relation between solar radiation and fire danger will be determined from laboratory and field tests. Such a study is necessary to determine the importance of season as a fire danger factor. Investigation of fuel moisture-weather relations on different aspects at several elevations will be started. Knowledge of these relations is necessary for the development of adequate networks of fire danger stations.

With its present facilities the Station cannot expand fire danger investigations in the near future. Present plans call for continuation of current sample plot work and an attempt will be made to bring up to date a summary of fire damage following both spring and fall fires in the Appalachian Mountains.

Accomplishments

Forest influence investigations are directed toward determining the principles underlying the effect of forest and forest practices upon water, land, and climatic resources, and toward interpreting these principles in terms of practical conservation measures. Such measures relate to water supplies for municipal, industrial, and recreational purposes, and to the correction of malpractices in land use that permit surface storm water to contribute to the depletion of valuable water and land resources.

At the present time little is known of the principles of efficient watershed protection and management, although the National Forest program in the eastern states has long been supported in part on the basis of watershed protection. Many conflicting points of view are being expressed as to the value of different types of land management upon water yield and flood regulation. It is to be expected that in the administration of public lands, watershed management should be placed on a more scientific basis. The principles of scientific watershed management can be determined only through a program of investigations in which the relation between vegetative cover and stream behavior is clearly demonstrated. The Appalachian Station is now proceeding, together with other researh agencies, in finding the basic facts of water behavior and run-off as they are related to forestry and forestry practices.

In order to develop principles of land management that will furnish desirable streamflow regulation, it is necessary to understand the manner in which the entire water cycle is influenced by the exploitation of the land. The logical areal unit on which many phases of the water cycle must be studied is the watershed. Consequently, the Station's major activity in forest influence investigations is a study of the precipitation recharge on unit watersheds, together with a complete analysis of the manner in which water is discharged from the watershed as run-off, transpiration, or evaporation losses. In all 32 watersheds ranging in size from ten acres to 1,800 acres are being studied within three major rainfall belts of the Southern Appalachian Mountains. These watersheds are representative of important land use types such as are commonly encountered throughout the region. Precipitation intensity records and stream discharge records have been recorded for all storms on twenty of these watersheds for periods of three years or more. Data have been analyzed with the objective of comparing the amount of streamflow regulation afforded by the different land use types. In general it has been found that land depleted by erosion and with inadequate vegetative cover will produce for heavy storms from 10 to 20 times the peak run-off that is

produced by similar land controlled by forest or other complete vegetative cover. The relation of vegetative cover to the frequency and magnitude of peak discharges from small watersheds is illustrated in the following table:

Percent of Total Number Storms
Greater Than 0.49 Inches Precipitation
Having Peak Discharges Within the Given Ranges
(July 1, 1935 to July 1, 1937) 1/

Land Use Type	Peak Discharge in c.f.s. Per Square Mile					
	Less than 20	20 to 99	100 to 999	1000 to 1499	1500 and Greater	Absolute Measured Maximum Discharge
Forest	88.2%	11.4%	0.4%	-	-	164
Depleted Cropland	40.7%	37.0%	22.3%	-	-	906
Depleted Pasture	36.9%	20.2%	40.5%	2.4%	-	1,005
Denuded	24.1%	16.1%	46.0%	9.2%	4.6%	3,836 2/

1/ Includes 1,463 watershed storms.
2/ Storm of September 5, 1937.

Not only has it been demonstrated that the amount of surface storm run-off is a function of the infiltration capacity of the watershed, but also it has been shown to what extent the infiltration capacity is governed by the land use types. With the accumulation of a greater number of observations, it has been possible to subject run-off data to a detailed analysis during the past year. Not only has the earlier indication of the close relationship of land use type to run-off been substantiated, but it may now be proven statistically that the run-off from a small drainage area having a uniform vegetative cover does not differ significantly between storms of the same type. In other words, it is possible to predict for all practical purposes the amount of total storm discharge and the peak discharge that may be expected from similar storms on other but similar watersheds under the same land use type. An application of the Unit Hydrograph method to small watersheds revealed certain correlations between the shape of the distribution graph, especially the peak percentage and width of base, with the physical characteristics of the watershed. Pluviagraphs were also prepared for certain streams to test the accuracy of the composite distribution graphs and to determine the usefulnes of the pluviagraph in the analysis of surface run-off phenomena. These methods of run-off analysis show considerable possibility for watershed analysis purposes.

The results obtained to date in the Station's watershed studies have a direct practical application to regional land use problems. These results show the amount of storm water that may be contributed by different land use types to the flood waters of the larger streams; they also serve to indicate the value of different land management practices upon the conservation of soil and water resources and to furnish a basis for comparing these watershed protection values with the costs of such measures. In land planning programs, the data obtained in watershed studies permit the selection of critical areas on which to concentrate watershed improvement practices to correct existing unfavorable land conditions. The correction of these conditions should insure a better regulated streamflow and a higher quality water resource for the future. Practical application of the results is also found in the design of culverts, storm sewers, small dams, bridges, and other engineering structures insomuch as the design of these structures is dependent upon a definite knowledge of the amount of storm water run-off with which these structures must contend.

In the southeastern states centuries of land exploitation have produced conditions of soil impoverishment and depleted vegetative cover. Such conditions are directly reflected in inadequate control of surface storm water, in serious soil erosion losses, and in a less favorable usable water production. The retirement of this depleted submarginal land from agriculture, as advocated in land planning programs now under way, requires that the forester obtain a technical knowledge of water regulation insomuch as he is being called upon to restore and manage large tracts of land principally for watershed protection. The restoration of depleted land may frequently be brought about by tree planting alone, but in many cases erosion is so active that site preparation in the form of contour ditches, check dams, and other minor engineering devices are required to control surface storm water and to stabilize the soil before trees can be planted. Within this field of soil protection the Station is cooperating with other agencies in studying methods of soil rehabilitation. An example of the Station's soil protection experiments through forestry is found in the Copper Basin of Tennessee, where black locust and other species have been planted on eroded land, completely denuded by smelter fumes. Here it has been found that the locust is the most satisfactory tree species for the particular site, but, more important, these studies have demonstrated that native grasses are able to become established in such a manner as to form a dense sod under the locust trees much more readily than under other species. In the field of practical watershed improvement the Station has carried out tests to determine the most economical methods for preventing soil sloughing from freshly cut banks and fills on National Forest roads.

The first experiments of this kind were made in 1934 in North Georgia, and in the Bent Creek Experimental Forest, and additional tests were made in 1935 and 1936. These experiments demonstrated different methods of preparing the sites for planting and tested different species that appeared to be suitable for the purpose of road bank planting. The

experiments have served as a demonstration study for practical workers, such as rangers, CCC Camp Superintendents, and Highway Departments in planning road bank protection in different localities. During the past year, demonstration tests have been made with open mesh cotton cloth for holding soil in place on road banks and fills, pending the germination of grasses and formation of sod. These tests located at the Coweeta Experimental Forest indicate that on isolated and relatively inaccessible areas such textile materials may be more applicable and economical than methods using natural material but requiring a large amount of labor. The greater cost of the cloth is more than offset by its simplicity of application, where labor costs are high.

As a part of the Station's comprehensive study of the water cycle, observations have been made over a period of years of the amount of precipitation lost to the soil because of interception by forest crown canopies. The Station has now completed the analysis of data collected in this study. The results indicate that the amount of precipitation intercepted by crown canopies is directly related to forest type, season of the year, and amount of rain. It has been shown that for the Bent Creek Experimental Forest, where the experiments were conducted, from 12 to 18 percent of the total precipitation occurring in the course of a year is actually lost to the soil due to crown interception. Formulae are now available for computing the amount of precipitation lost through crown interception for four of the more common forest types of the region. The final results of the preliminary phase of the study on interception are now in manuscript form awaiting publication. The study furnishes a basis for a better understanding of this phase of the water cycle, and supplies another known factor in balancing the water recharge-discharge equation on forested drainage areas.

Further knowledge of the influence of forest upon the water cycle has been obtained through observations of local climates in the Copper Basin of Tennessee. Here, as a part of watershed studies, meteorological stations have been established within the three major vegetative zones. Records indicate the existence of distinct local climates within each of the three zones. The practical applicability of these results lies in the fact that they give a scientific basis for interpreting the influence of forest and of other vegetation upon meteorological conditions within its immediate vicinity. For the Copper Basin area it has been clearly demonstrated that the vegetation has a very effective control on temperature, wind velocity, and air saturation deficit. The data also indicate that there may exist a relation between complete denudation and precipitation, there being a lower total annual precipitation within the denuded zone of the Copper Basin than for contiguous areas. These findings indicating that local climates have been created within the Copper Basin area by destruction of vegetation have been prepared for publication.

Plans for 1938

Streamflow measurements and watershed standardization will be continued on thirty-two watersheds on which streamflow measuring devices have been completed. Eight additional weir installations are contemplated.

Certain phases of water utilization and consumption studies will be expanded to include: (1) direct measurement of water vapor transpired, (2) calculation of transpiration and evaporation through soil moisture sampling and a determination of soil moisture movements, (3) analysis of the diurnal fluctuation from stream head discharge graphs, and (4) a limited use of potometers or lysimeters.

Analysis of hydrological records will consist of: (1) routine statistical analysis of all streamflow records, (2) unit hydrograph, distribution graph, and pluviagraph analysis, which indicate the constant behavior of run-off from individual drainage areas, and permit the comparison of different storms within the drainage area, (3) infiltration capacities which are a more precise determination of the constancy of streamflow behavior within a watershed and between different watersheds, and (4) drainage area coefficients and constants to be used in rational run-off formulae.

FLOOD CONTROL SURVEYS

Accomplishments

The Station has been drawn into close contact with land use planning programs in the region through its activities in the preparation of preliminary flood control surveys as authorized by the Flood Control Act of June 22, 1936. The purpose of these surveys is to determine the basis on which various bureaus of the Department of Agriculture can best eliminate unfavorable watershed conditions that are contributing to floods. The Station serves as chairman of two field committees designated to prepare reports on seven major streams of the southeastern states, and is cooperating in the preparation of reports on five other drainages. The report on the Pee Dee has been completed, and the reports on the Santee and Potomac are nearing completion. The surveys indicate that forestry must play a major part not only in watershed improvement and water conservation, but also in the restoration of land values and increased economic returns from the management of the land. The surveys also indicate that forestry has an important place in solving the economic and social problems that are directly or indirectly related to floods.

Some of the land use changes that are indicated as flood control measures by the preliminary flood control surveys are: (1) State and Federal acquisition of depleted and tax delinquent land not now under suitable protection and management, (2) retirement of so-called marginal and submarginal cropland to forests or pastures, (3) farm organization insuring better management of farm woodland and pasture, and (4) pasture improvement through mechanical structures such as lateral furrows, terraces, etc., and cropland management for the regulation and control of surface storm water.

The preliminary flood control surveys also indicate that for specific areas where damages from floods are high and soil and water resources greatly depleted, a conservation program will be justifiable on a probable cost to expected benefits basis. The conservation program in most instances can not be expected to displace justifiable engineering flood control structures, but in most cases will facilitate in bringing about a more complete regulation of streamflow and will in general promote the conservation of our soil and water resources. In some instances where flood damages are not concentrated in urban areas, a conservation program may be the only practical solution to streamflow regulation.

Plans for 1938

Provided present flood control survey activities are continued and funds are made available, surveys on the following drainage basins are contemplated for 1938:

Drainage Basin	State or States
James River and tributaries	Virginia and West Virginia
Roanoke River	Virginia and North Carolina
Tar-Neuse River and tributaries	North Carolina
Cape Fear River	North Carolina
Kanawha River and tributaries	West Virginia, Virginia, and North Carolina
Big Sandy River and tributaries	Kentucky and West Virginia
Tennessee River and tributaries	Tennessee, North Carolina, Virginia, Kentucky, Georgia, Alabama, and Mississippi

Accomplishments

A Forest Survey organization was established at this Station in April 1936 to extend the national program to the five states in the Appalachian territory. The need for reliable information regarding the forest resources of the region was particularly urgent as a huge expansion in the pulp and paper industry was beginning and both the industry and public agencies wished to determine the extent that pulpwood production could be developed without injury to existing wood-using industries or depletion of the timber resources. Recent developments in land use planning have also resulted in a demand by land planning agencies for forest resource data.

Field work on the Survey was begun in July 1936 in South Carolina and later extended to the Piedmont area of the State. The field procedure adopted followed the general plan developed at the Southern and Lake States Stations. Parallel compass lines were run at ten-mile intervals across country and one-quarter acre sample plots were taken every 10 chains on line. On forest plots detailed records were made of the species, size, and condition of each tree. Increment borings were made on sample trees for growth calculations. On plots in non-forest areas only the type of land use was recorded.

By the end of the calendar year 1936 all of the State of South Carolina not previously covered by the Southern Station (approximately 15 million acres), had been surveyed, and the work extended to Piedmont North Carolina. Work on the coastal plains was completed early in December, 1937, and the crews furloughed, as no additional funds were available for field work.

The present status of the inventory field work is shown by states in the following table.

Status of Inventory Field Work
Territory of Appalachian Station
January 1, 1938

State	Total land area	Area covered by Southern Station	Area covered by Appalachian Station	Percentage completed
	M acres	M acres	M acres	
South Carolina	19,517	5,187	14,330	100
North Carolina	31,194	-	25,571 1/	82
Virginia	25,768	1,000 2/	-	4
West Virginia	15,374	-	-	0
Kentucky	12,800 3/	-	-	0
Tennessee	11,400 3/	825 2/	-	7
Georgia	4,000 3/	4,000	-	100
Totals	120,053	11,012	39,901	42.4

1/ Mountain unit not covered.
2/ Norris Dam Watershed.
3/ Includes only that portion of state in Station territory.

Approximately 70 million acres of the Station's territory remains to be covered, including the coastal portion of Virginia with its valuable pine pulpwood resources and the mountain hardwoods region extending from West Virginia to Georgia.

The computations necessary for working up the mass of field data were begun for each survey unit as soon as field work was completed, using the Hollerith punch card method of machine tabulating as adapted by the Southern Station. As funds would not permit the installation and operation of the equipment necessary for compiling and tabulating the data in Asheville, arrangements were made with the Southern Station to have this work done in New Orleans. Despite the inconvenience of remote control of the tabulating, this arrangement has proved to be entirely satisfactory because of the close cooperation between the two Survey organizations.

During the year the basic tables of area and timber volumes for the South Carolina units, card punching for the three North Carolina units, and tabulations for the North Carolina Piedmont unit were finished.

The preliminary survey figures of forest area and timber volumes for the State of South Carolina are shown in the following table. The figures are subject to correction as computations are completed and checked, but such corrections will be of minor importance and will have no significant effect on the totals.

Forest area and timber volumes 1/
South Carolina

	Area	
	Acres	
Total land area	19,426,000	2/
Total forest area	10,678,000	(54.9%)
Sawtimber	6,204,000	
Cordwood	3,659,000	
Reproduction	692,000	
Clearcut	123,000	
	Timber volume	
	M bd. ft.	3/
Total	30,354,000	
Softwoods	18,682,000	
Hardwoods	11,672,000	

1/ Includes data from South Carolina unit #1, surveyed by Southern Station.
2/ Does not include coastal islands of Beaufort County.
3/ International 1/4" kerf rule.

Growth and mortality computations for the South Carolina units were started in the latter part of the year and were well advanced by January 1938. The method of determining mortality has been much discussed during the past few months. The discussions emphasized the fact that the subject is one of the most perplexing problems in forest mensuration today.

Depletion field work for the South Carolina units was completed during the year. With the exception of some of the very small portable mills, all wood-using industries in the units were visited and records of their 1936 production obtained. In addition, studies were made of domestic use of wood on farms and in urban communities. This resulted in the most comprehensive census of the wood-using industries of the State ever made. Although these data have not been completely tabulated, the preliminary results show that the number of sawmills and their production, as recorded by the Survey, will considerably overrun the totals reported by the Bureau of Census. This difference is due chiefly to the large number of small portable mills which do not report to the census. It may be of interest to note that nearly one-half of the total volume of lumber produced in the State in 1936 was cut on mills averaging less than 10,000 board feet per day.

If the Forest Survey data are to be kept up to date, it is essential that accurate statistics on forest products be available. If they are not available from the Bureau of Census, it will be necessary for the Survey to canvass the industry. Such duplication would be both expensive to the Government and irritating to the mill operators. Every effort should be made to avoid it by coordinating the work of the various agencies interested in the collection of production data.

Wood for fuel is one of the major uses in this region, yet it is extremely difficult to obtain accurate information regarding the volume so utilized. Field studies show that few farmers know how much wood they consume in a year, and even fewer can tell what proportion of their wood comes from sound live trees and what proportion from dead trees, culls, or mill waste. The volume of wood used for fuel in urban communities is also difficult to determine with any degree of accuracy. The Forest Survey has made estimates of the total volume of wood utilized for fuel in the South Carolina units but realizes that these estimates are a weak point in the depletion data. Attempts are being made to have the agricultural extension services in the various states collect detailed information regarding the fuelwood used on farms cooperating with them. Such records would materially strengthen the Survey fuelwood depletion figures.

Although computation work on the growth and depletion phases of the Survey was not completed for the South Carolina units by the end of the year, preliminary steps were taken for the preparation of the report on the forest resources of the State. Arrangements were made with the Southern Station to supply the data for the portion of the State worked by their Survey organization (unit #1) so that they could be included with others for the State. An outline for the report was prepared and considerable economic and historical information assembled.

In addition to its own activities, the Survey organization cooperated with several other agencies on special projects during the year. These included an economic survey of the timber resources of Cherokee County, N. C., in cooperation with the Department of Forestry Relations of the T.V.A., Farm Security Administration, Region 8, and the Nantahala National Forest; a report on the pulpwood resources of coastal South Carolina and later a preliminary report on the forest resources of the State as a whole, in cooperation with Region 8, the Division of State and Private Forestry in Washington, and the State Forester's office; the compilation of volume, growth and depletion figures for the Central South Carolina Subunit in cooperation with Region 8 and the State Forester's office; and a study of forest taxation in North Carolina in cooperation with the Forest Taxation Inquiry and the North Carolina Classification Amendment Commission.

Plans for 1938

Although approximately 70 million acres of the Station's territory remain to be covered by the Survey, no further field work will be possible until additional funds are available. The mountain unit of North Carolina will be given priority in planning future work as this is the only portion of North Carolina not completed. Tentatively, eastern Virginia has been assigned second priority so that the coastal pine region may be completed and data made available to answer the questions being raised regarding the adequacy of the timber resources of the region, in relation to the tremendous expansion of the pulpwood industry. There has also been considerable demand for Survey information in Tennessee, and plans are now under consideration by agencies in that State for providing the Survey with financial aid. If these plans materialize they will undoubtedly be a controlling factor in determining priority of areas to be worked.

The final computations of growth and depletion should be finished for the South Carolina units early this year and it is planned to release brief statistical reports of volume, growth and depletion for each unit as soon as figures are available. The complete report for the entire State should be ready for publication in the latter part of the year.

Depletion field work will be started early in the year in the North Carolina units already covered by the inventory survey. Computations of inventory and growth for these units will also be carried forward during the year and statistical reports prepared. The State report for North Carolina will be delayed, however, until the field work can be extended to the mountain unit.

FOREST PATHOLOGY

In Cooperation With
Bureau of Plant Industry, Division of Forest Pathology

Accomplishments

A study of decay following fire was made to develop a mechanism by which the amount of decay following fire-scarring can be predicted. Work on this project was begun this year with white oak. Almost a thousand fire-scarred trees were studied on two stave operations, one in West Virginia and one in North Carolina. The results so far indicate that if the wound width, about 18 inches above ground, is known, future cull to be expected can be estimated within a reasonable standard error for large numbers of trees. Many factors other than wound width were included in the analysis, but their effect in improving the estimate appeared to be negligible. Because of difficulties in sampling and in the analysis of this type of data, definite conclusions on the possibility of predicting future cull following fire-scarring with acceptable accuracy await further study. In the trees examined, amount of decay increased parabolically from about 1 board foot for 4-inch wounds to 160 board feet for 30-inch wounds. Practically no decay resulted from fire wounds less than 4 inches wide 18 inches above ground.

Most of the decay in two shortleaf and loblolly pine stands located in Arkansas and Texas was red-heart (Fomes pini), which developed from branch stubs in almost all cases. The most common butt rot fungus was Polyporus schweinitzii, which usually entered from fire wounds. On a basis of board feet, log scale, the cull percent due to rot ranged from .2 to 2.4 for the different species and areas; on a cubic feet basis from .1 to 1.3; on a lumber tally basis from .3 to 1.8; and based on dollars from .8 to 2.9 percent. The financial loss included both cull and degrade. So far as the writers are aware, this is the first study to give decay losses for southern pine in terms of money in addition to volume. In this study percentage value loss considerably exceeded the percentage of cull based on log scale, the latter being the standard figure estimating loss. The discrepancy between money and volume loss is due to the fact that the former includes degrade, and the latter does not.

A technical bulletin manuscript was prepared on the results of three years' investigation of factors correlated with basal decay in sprout oaks. The white oak group was much less susceptible to decay from the parent stump than the black oak group. The percentage of sprouts with butt rot that originated in the parent stump rose from 9 in sprouts that originated from buds below ground level to 42 in sprouts that started 4 inches above ground. There was a direct relation between the size of parent stumps and percentage of sprouts decayed. Sprout stands that arose following burning of cut-over areas were uniformly more sound than where the areas were not burned. Over 80 percent of the decay was caused

by Stereum gausapatum. This fungus can not spread from the parent stump to the new sprouts until the sprout has formed a heartwood union with the stump. It is a bole as well as a butt fungus, having been found growing actively more than 16 feet up the trunk. Recommendations for keeping the decay hazard in oak sprout stands to a minimum have been prepared.

Pruning wounds on oaks made from April through July start callusing-over immediately. If the wounds are made in August or later, healing does not begin until the following spring, and in the meantime the bark dies back from the wound. There is a decided advantage, therefore, in spring pruning, from the healing standpoint.

Observations on yellow poplars attacked by Nectria canker and partially released 3 years ago strongly indicate that a vigorously growing tree will heal out its cankers, while a suppressed tree is likely to be girdled by them.

A study of the pathological effect of increment boring was begun on white oak, scarlet oak, yellow poplar, sugar maple, white pine, shortleaf pine, and pitch pine. Six borings on each of 10 trees of the above species were made, of which one-third slanted upward, one-third downward, and one-third were made horizontal. Half were plugged with locust heartwood plugs, and half were left open. At intervals these trees will be examined for defects that may follow the borings. These examinations will involve cutting some of the trees to note any possible internal defects.

Examination of mimosa root inoculations made on trees in situ at Tryon in 1936 showed the wilt fungus isolated from diseased trees to be capable of producing the disease. Although the pathogenicity of this fungus can not be said to have been proven, because of the opportunities for natural infection at Tryon, the combined evidence of earlier inoculations and isolations leaves little doubt but that it is responsible for the disease. The disease was found to occur in trees growing in pure sand, loams, and heavy clay, and in soils with pH values from 4.5 to 7.8. The disease appeared at Charlotte, N. C., this year, apparently for the first time. Last year Van Wyck, S. C., and Wadesboro, N. C., reported infected trees for the first time. It seems to constitute a real threat to the mimosa tree in this country.

The leaf and twig rust of hemlock caused by Melampsora farlowii continues to cause thousands of dollars' loss each year in commercial nurseries by killing new growth and rendering the trees misshapen and unsightly and therefore unsalable. Observations this year showed the disease to occur in a mild form in the forest, from West Virginia to Georgia.

Plans for 1938

In the study of decay following fire the objective is eventually to study all of the commercially important hardwoods in the region, in order to be able to predict the decay losses following any forest fire.

The study of sprout oaks will be continued with emphasis on the effects of cutting or girdling part of the components of a sprout clump, the best time of year for pruning or clump thinning to obtain optimum healing of wounds, the best time of year for cutting to obtain the maximum proportion of sprouts with low origins, and to determine up to what size companion sprouts can be cut with safety, and what types of sprout clumps can be partially thinned with a minimum decay hazard.

A considerable amount of data already taken on the subject of felling versus girdling trees with Nectria cankers will be analyzed.

Observation of the mimosa wilt, with the hope of discovering conditions unfavorable to it, will be continued.

Spraying experiments for the control of the hemlock twig rust and life history studies of the fungus are planned for the coming year.

Service visits will be made to C.C.C. camps, the work including giving illustrated talks on pertinent forest pathology problems, check-ups on areas on which T.S.I. work has been done in the past, and bringing up to date the pathology recommendations involved in T.S.I. instructions.

FOREST ENTOMOLOGY

In Cooperation with
Bureau of Entomology and Plant Quarantine

Accomplishments

Field and laboratory studies of the white grub (Phyllophaga), begun in 1932 in State Forest nurseries of North Carolina and South Carolina, were completed by the end of the calendar year 1937. Although complete analyses of the information gathered have not been made, it was found that:

(1) While no chemical proved to be both effective in preventing grub infestation and harmless to seeds or seedlings, a practical remedial control by undiluted carbon disulphide was developed.

(2) As brought out previously, mechanical barriers are effective in preventing seedbed infestation by white grubs.

(3) Because most serious injury is caused by larvae in their first year, all indications are that damage can be controlled only by mechanical barriers at the time of beetle oviposition or by a chemical control as mentioned in (1) above, and not by any proved nursery practice.

Investigations were continued to find methods, chemicals, and dosages necessary to control insects attacking trees, to preserve these attacked trees until they can be salvaged, and to preserve timbers used for rustic construction, posts, poles, etc. Further determinations of chemical distribution were made. Chemically treated standing trees, rustic logs, and test stakes were inspected to determine the insect-killing and wood-preserving values of the chemicals used. Cooperative work for analyses was continued with the Coeur d'Alene, Idaho, Station; and cooperative work for treatment and analyses was started with the Berkeley, California, Station.

A study of hickory seasoning and starch depletion was carried on in conjunction with powder-post beetle investigations. Various methods of seasoning and drying were tested. From sections subjected to these different treatments and from standing and felled trees, wood samples were collected each month and analyzed for starch content.

The powder-post beetle investigations, started in 1937, thus far have dealt primarily with the building up of a beetle population in different woods. Tests were made of some probable control chemicals as they affect infesting insects and as they react on various wood finishes.

Intensive investigations for the control of termites in buildings were begun. A number of local residences were treated with test controls; and inspections were made of treatments by commercial concerns and home owners.

Plans for 1938

The data from the white grub investigations will be analyzed and prepared for publication.

If the Southern Pine Beetle returns in sufficient numbers, further studies of control will be made. Although few treatments of healthy trees are proposed, examinations of treated trees and test logs, and chemical analyses of wood samples from treated trees will be continued.

The life history of the powder-post beetle, the effect of seasoning and starch depletion on beetle infestation, and methods for control will be investigated.

Additional tests and inspections of buildings treated for termite control will be conducted.

FIRE-WEATHER FORECASTS

The issuance of daily fire-weather forecasts during dangerous periods is the basic contribution of the Weather Bureau to fire control by Federal, state, and private agencies. While warnings are usually telegraphed to fire control organizations, a more effective and widespread dissemination of weather information was made possible during the past year through the cooperation of publicly and privately owned radio stations which made daily fire-weather broadcasts.

To meet the increasing demand for more detailed forecasts of weather changes much research must be done. As new records become available, the distribution of rainfall over the Southern Appalachians is being studied. While specific trends in temperature and humidity have been found, data are as yet too few for the establishment of reliable averages. Recent investigations on the variations of humidity with altitude bring out the fact that, although humidity normally increases with altitude, there are unusual instances of extremely low humidity on the highest peaks. The influence of slope on temperature and humidity is another subject which should receive more study than has been given it in the past. In many cases, accurate interpretation of fire-weather forecasts depends upon knowledge of these and other local peculiarities.

To produce comprehensive and accurate records and forecasts of greater detail, the Weather Bureau needs more stations in key locations, additional meteorological equipment, and a better-trained personnel of fire-weather observers. Improvements in these conditions are gradually being made by cooperation with Federal and state agencies interested in fire control, but much remains to be done.